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HELIPORT AT SUDBURY GENERAL HOSPITAL

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ELLIOT LAKE LABORATORY

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HELIPORT AT SUDBURY GENERAL HOSPITAL

by

M.U. Savich* and B.S. Harris**

ABSTRACT

This report is an open discussion on the proposed heliport at the Sudbury General Hospital, its potential as a noise hazard and possible solutions.

The study indicates that use of an acoustical barrier is not an efficient method of noise attenuation at the hospital. Our recommendation is that the glass in the windows of the rooms affected should be changed to acoustical glass on 'double windows'. This would provide an effective form of noise attenuation. Thus, the implementation of a heliport at the Sudbury General Hospital is feasible.

The results of this study show the potential for assisting not only the Sudbury General Hospital, but the Northern Ontario community at large.

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RAPPORT SUR L'HÉLIPORT DE L'HÔPITAL GÉNÉRAL DE SUDBURY

par

M.U. Savich* et B.S. Harris**

RÉSUMÉ

Ce rapport constitue une discussion générale au sujet du futur héliport de l'Hôpital général de Sudbury, des risques de bruits élevés et des solutions possibles à ce problème.

L'étude effectuée démontre que l'utilisation d'un écran acoustique ne représente pas une méthode efficace pour réduire le bruit à l'hôpital. Nous recommandons de changer le verre des vitres par du verre acoustique posé sur les châssis doubles des fenêtres concernées. Ceci devrait servir de moyen efficace pour diminuer le bruit. De cette façon, il sera possible de construire l'héliport à l'Hôpital général de Sudbury.

Les résultats de cette étude démontre la possibilité de venir en aide non seulement à l'Hôpital général de Sudbury, mais aussi à toute la communauté du nord de l'Ontario.

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CONTENTS

	Page
ABSTRACT	i
RÉSUMÉ	ii
INTRODUCTION	1
INSTRUMENTS	1
MEASUREMENTS OF NOISE AND VIBRATION IN THE HOSPITAL PRODUCED BY THE HELICOPTER	2
NOISE CRITERIA CURVES	5
ACOUSTIC BARRIER	9
BARRIER - INSERTION - LOSS FORMULATION AND APPROXIMATION FOR BARRIERS	10
SOUND TRANSMISSION THROUGH WINDOWS	12
HELICOPTER AS A SOURCE OF NOISE	14
CONCLUSION	16
ACKNOWLEDGEMENTS	16
REFERENCES	17
APPENDIX A - Time history graph from 14.34 h to 15.16 h,	

FIGURES

No.		
1.	Heliport at Sudbury General Hospital	3
2.	Time history graph in the Intensive Care Unit at the Sudbury General Hospital during the experiment	4
3.	Frequency spectrum of noise in rooms at Sudbury General Hospital	6
4.	The Noise Criteria (NC) curves were plotted using the data from the frequency spectrum in rooms	7
5.	The Preferred Noise Criteria (PNC) curves were plotted using the data from the band pressure levels	8
6.	A semi-infinite barrier (general)	11
7.	Insertion - loss approximation for barrier at Sudbury General Hospital	13
8.	Frequency spectrum of noise at the helicopter Bell 212 at Sudbury General Hospital	15

TABLES

No.		Page
1.	Noise in hospital during experiment with the helicopter	2
2.	Ranges of Noise Criteria (NC) and Preferred Noise Criteria (PNC) curves	9
3.	Determination of Sound Transmission Class (5) STC - ratings of windows and glazing	12
4.	Noise from helicopter at a distance of 40 feet	14
5.	Noise inside helicopter	16

INTRODUCTION

Noise measurement in the Sudbury General Hospital is directed towards the following objectives:

1. To identify noise in the A-weighted network of the helicopter in the Intensive Care Units Room, X-Ray Special Procedures Room and Technical Director's Office.
2. To obtain representative full octave band measurements and analyses of noise in Intensive Care Units Room, X-Ray Special Procedures Room and Technical Director's Office.
3. To give solutions for sound level attenuation in Intensive Care Units Room, X-Ray Special Procedures Room and Technical Director's Office, if necessary.

The scope of this report is to open discussion on the proposed heliport at the Sudbury General Hospital, its potential as a noise hazard and possible solutions.

The results of this study show the potential for assisting not only the Sudbury General Hospital, but the Northern Ontario community at large.

INSTRUMENTS

All measurements were taken using the Brüel and Kjaer Precision Integrating Sound Level Meter Type 1613, Level Recorder Type 2306, Sound Level Meter Type 2205, and Integrating Vibration Meter Type 1513. The sound level meter and integrating sound level meter were used to observe the sound levels. Both instruments were operated on the A-weighted network and calibrated with the calibrator before and after measurements. Time history sound level measurements were taken with the sound level meter and a portable level recorder. The level recorder gave a graphical display of the sound level as a function of time (Appendix A). For frequency analysis an external filter was connected

to the precision integrating sound level meter. Records of such surveys show data and location of the test. Vibration records in acceleration and velocity modes were taken only in X-Ray Special Procedures Room.

MEASUREMENTS OF NOISE AND VIBRATION IN THE HOSPITAL PRODUCED BY THE HELICOPTER

During the time period when the helicopter was hovering over the proposed landing site, measurements were taken in the hospital in (Fig. 1):

- The Intensive Care Units Room
- X-Ray Special Procedures Room, and
- Technical Director's Office.

Measurements were taken by the window in a five-bed area of the Intensive Care Unit (Fig. 2). Staff on duty reported that there was no apparent effect on the equipment in operation in the I.C.U. at that time. The staff noted a significant amount of vibration of the windows by 'bed 7', and to a lesser degree of the window where the test was taken. Table 1 shows the results of all measurements taken at the hospital.

Table 1 - Noise in hospital during experiment with the helicopter

Location	dBA				Remarks
	Background Noise	Low	High	Open Window	
Intensive Care Units Room	63	64.5	82.5	-	Full of patients
X-Ray Special Procedures Room	56	57.5	58	-	Instrumentations increased noise
Technical Director's Office	58	65	67	84 to 90	Open door

In the X-Ray Special Procedures Room there was no increase in noise. The main concern was that the helicopter outside a room could cause the walls

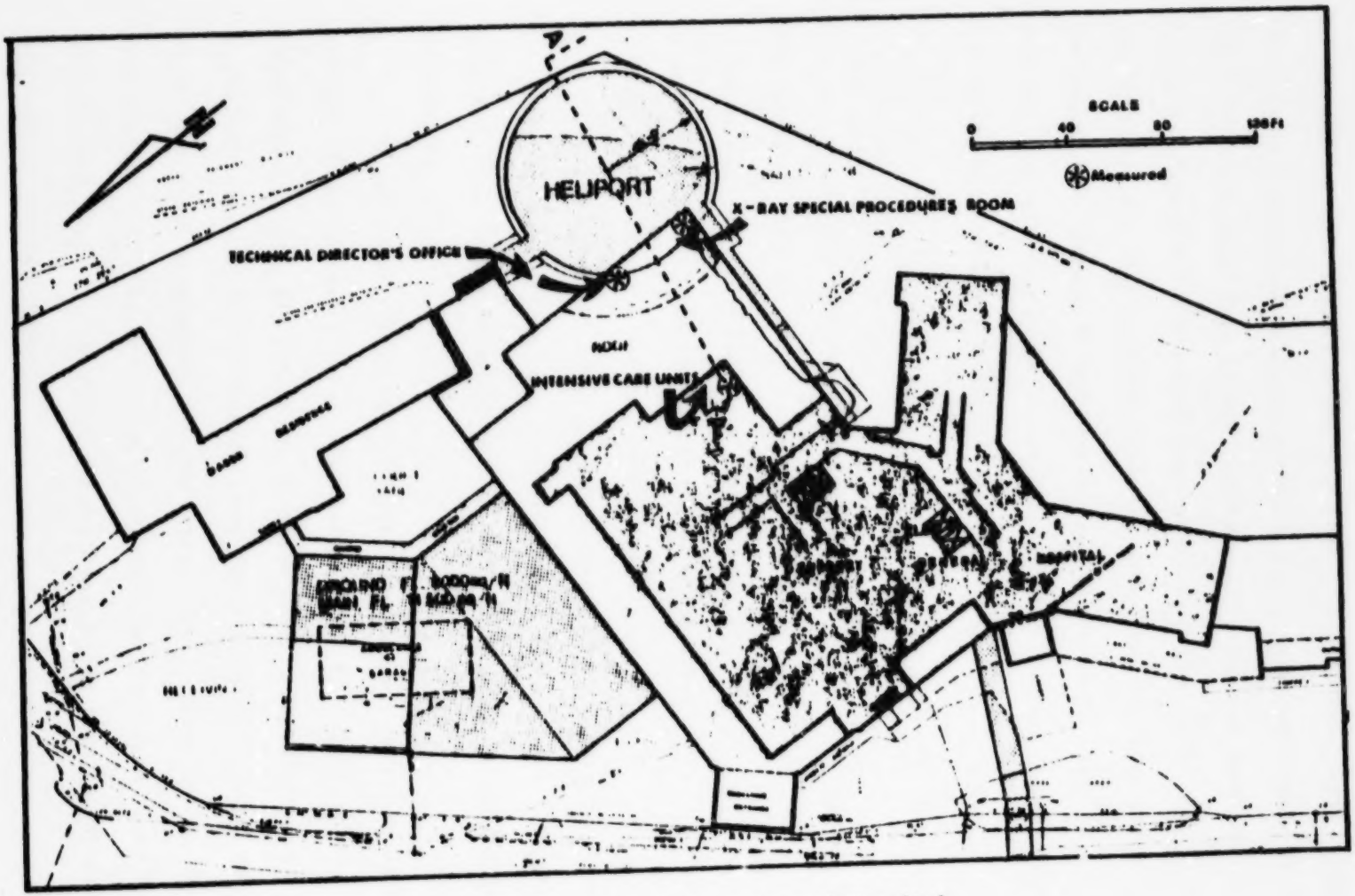


Fig. 1 - Heliport at Sudbury General Hospital.

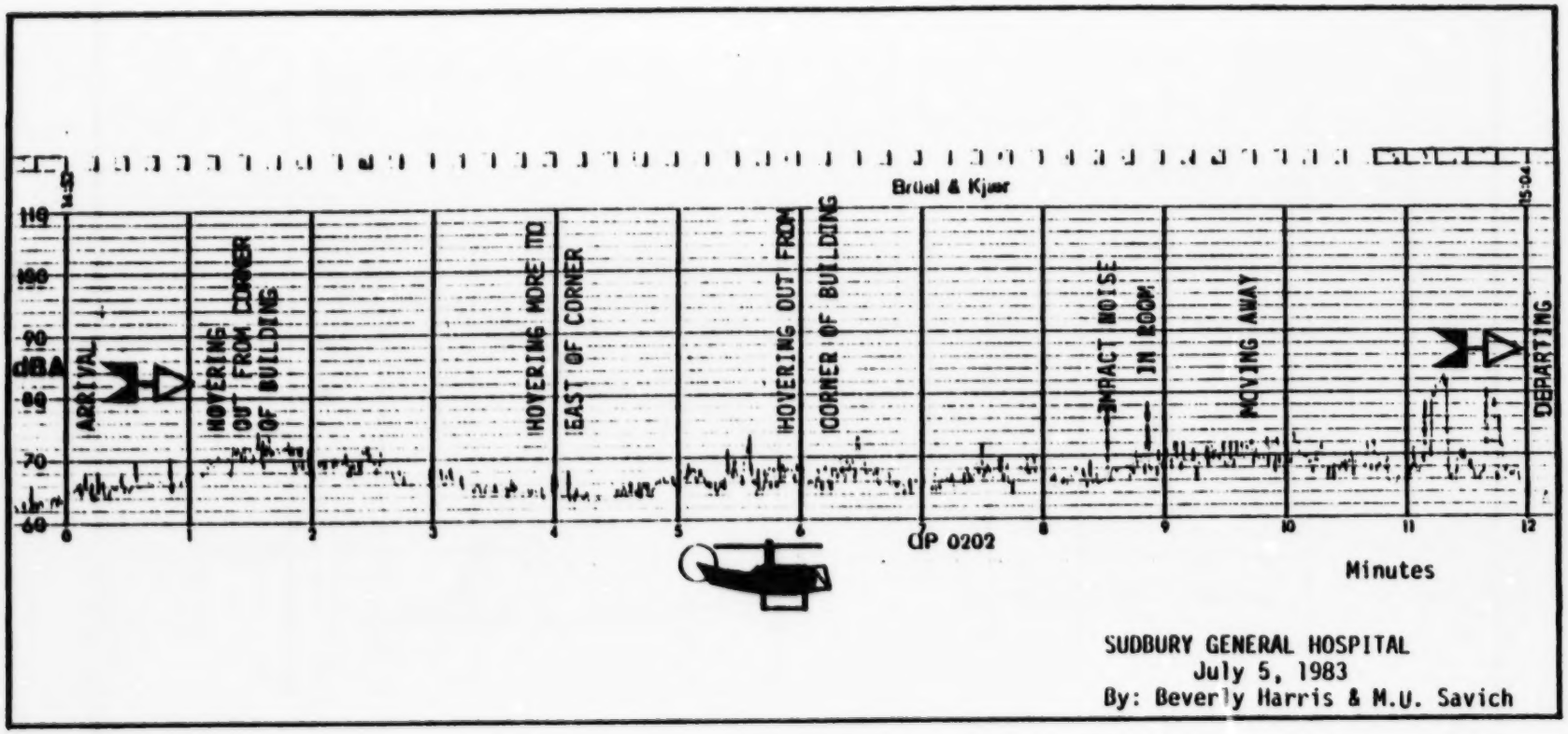


Fig. 2 - Time history graph in the Intensive Care Unit at the Sudbury General Hospital during the experiment.

to vibrate and thus produce noise in a room. In addition, floor vibration could cause problems if delicate operations were being performed, or if sensitive instruments were present nearby. All vibration measurements are very low. They did not show any readings on vibration meter type 2513. In the Technical Director's office noise was around 66 dBA: with the window open the levels were between 84 and 90 dBA. All measurements taken inside the hospital indicate that noise is not a significant factor. Rather, the psychological effect may be more important.

NOISE CRITERIA CURVES

The octave-band noise spectrum in rooms at Sudbury General Hospital was measured (Fig. 3) in:

- Intensive Care Units (only one patient)
- X-Ray Special Procedures Room (room was empty), and
- Technical Director's Office (room was empty).

Total noise estimated in dBA from the octave-band noise levels given in the first eight columns are in approximate agreement with the total noise measured which indicated reasonably constant conditions during the period of measurement.

A method of rating the background noise level in a room is accomplished through use of Noise Criteria (NC) curves (Fig. 4). These curves were established in 1957 for rating indoor noise (1,2). Each curve specifies the maximum octave-band sound pressure level for a given NC rating. As the area of noise control progressed over the years, the NC curves led to their modification (2). The new curves are called the Preferred Noise Criteria (PNC) curves (Fig. 5). Although these curves differ from the NC curves, they are used in the same manner.

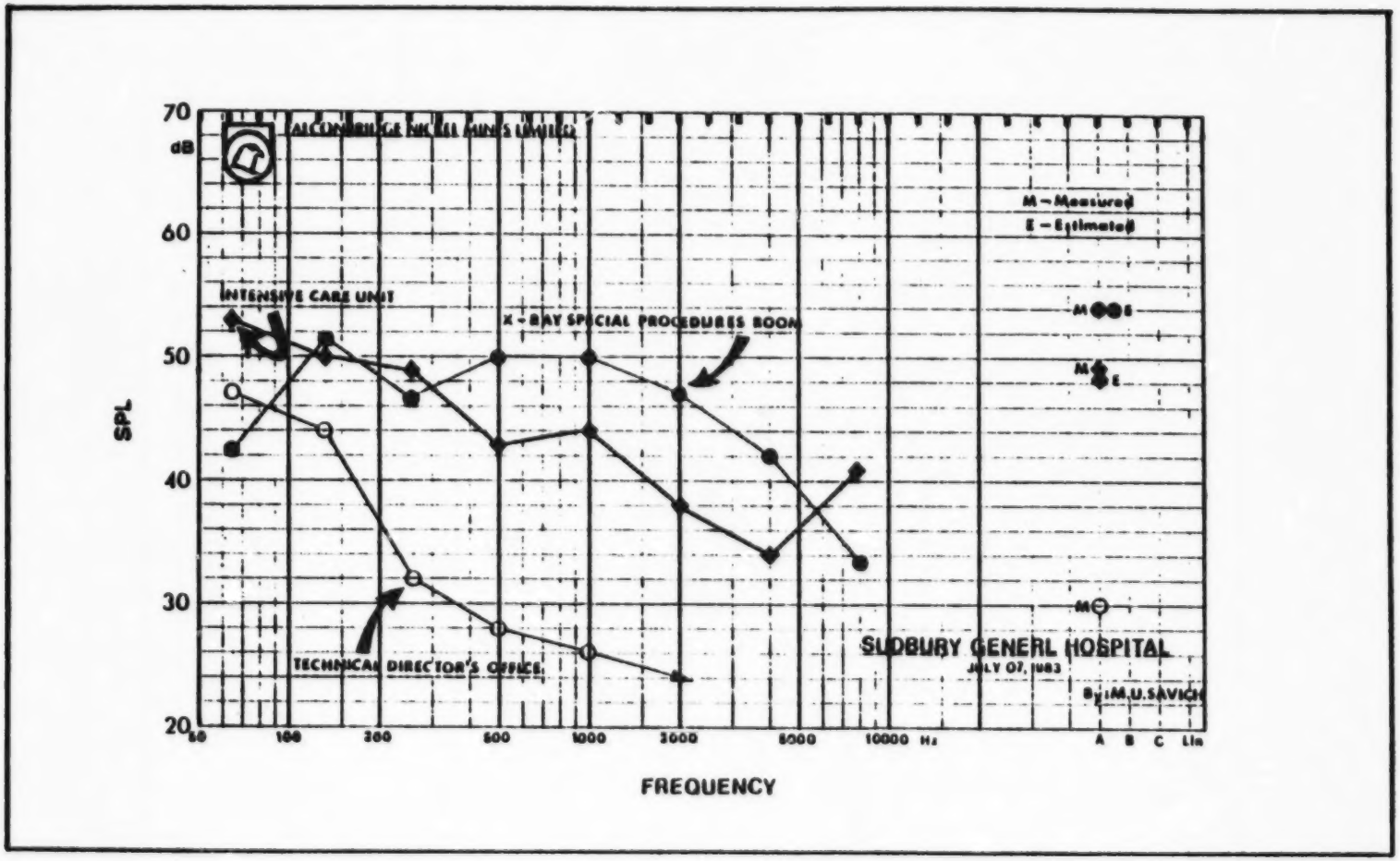
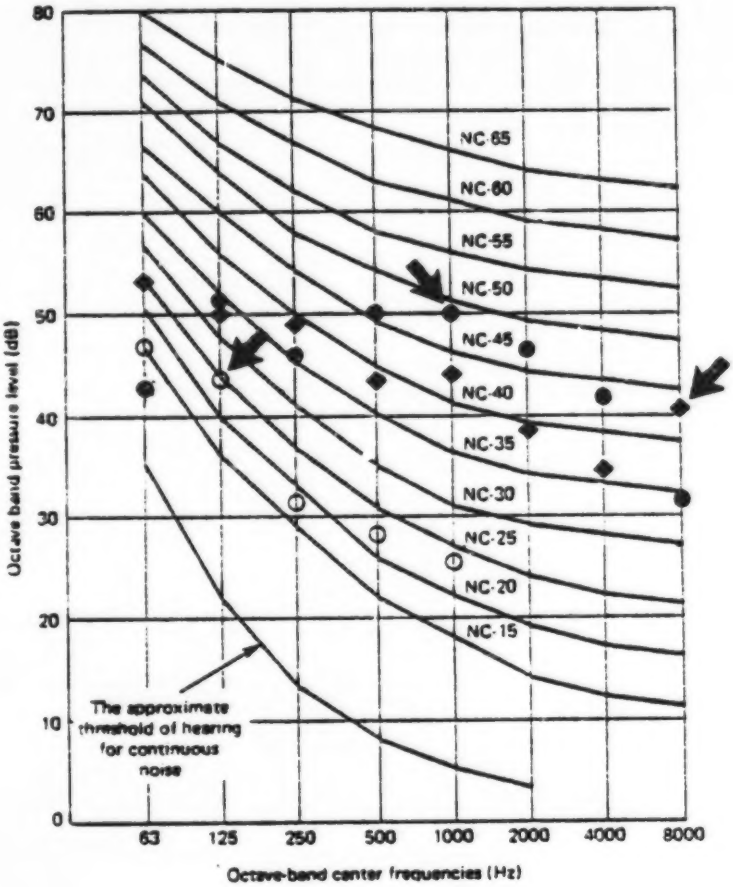


Fig. 3 - Frequency spectrum of noise in rooms at Sudbury General Hospital.



NOTE:

◆ Intensive Care Unit (NC-43.5)

● X-Ray Special Procedures Room (NC-48.5)

○ Technical Director's Office (NC-25)

Fig. 4 - The Noise Criteria (NC) curves were plotted using the data from the frequency spectrum in rooms.

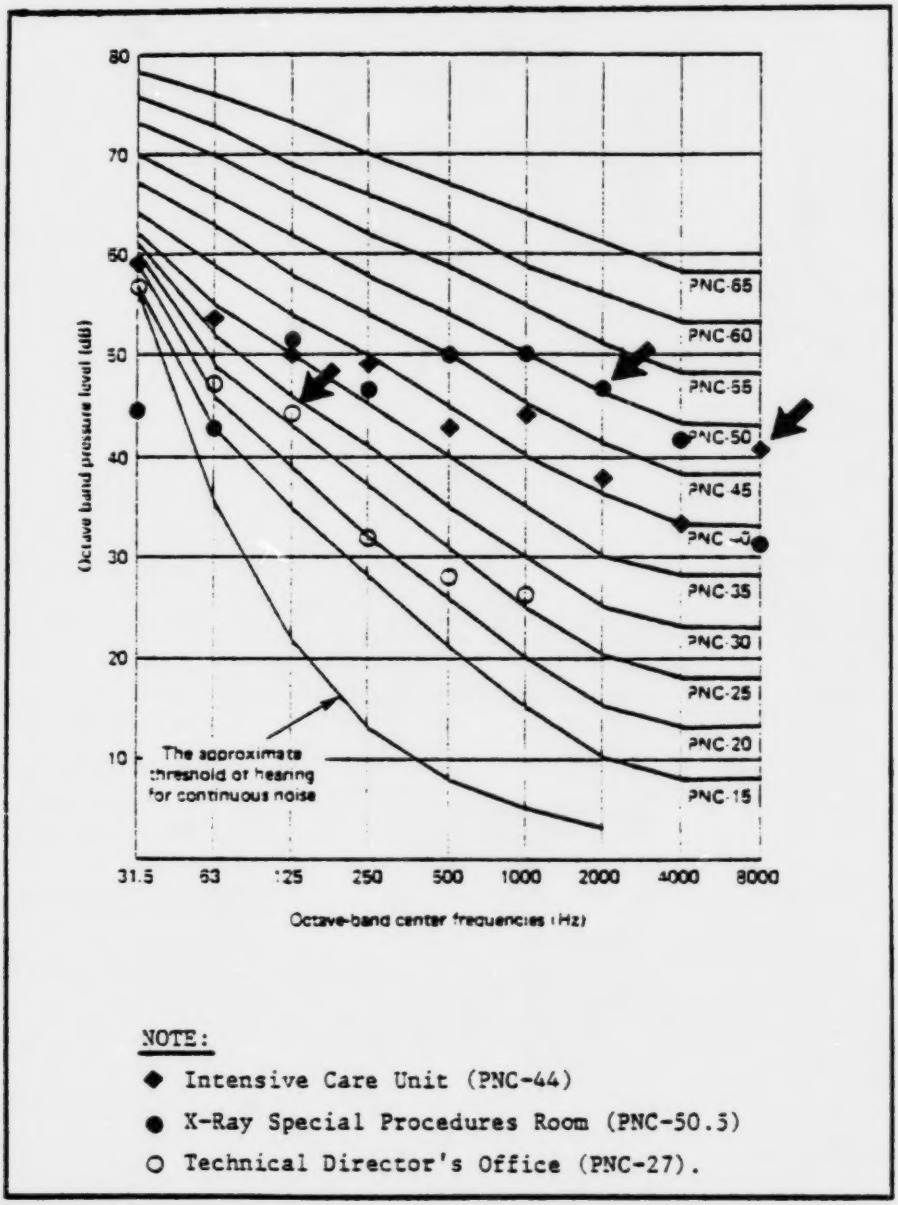


Fig. 5 - The Preferred Noise Criteria (PNC) curves were plotted using the data from the band pressure levels.

Recommended noise criteria ranges for steady background noise in certain indoor areas are listed in Table 2 (3):

Table 2 - Ranges of Noise Criteria (NC) and Preferred Noise Criteria (PNC) curves

Location	NC Curve	PNC Curve
1. Sleeping quarters	25 - 35	25 - 40
2. Living quarters	35 - 45	30 - 40
3. Office or classroom	30 - 35	30 - 40
4. Recording studio	12 - 20	10 - 20
5. Retail store or restaurant	35 - 50	35 - 45
6. Laboratory or engineering	40 - 45	40 - 50
7. Computer areas	45 - 60	45 - 55

From the octave-band noise spectrum in rooms in Fig. 4 and 5, and Table 2 the following was found:

	NC Curve	PNC Curve
- Intensive Care Unit (= Laboratory or Engineering)	40 - 45	40 - 50
- X-Ray Special Procedures Room (= Computer areas)	45 - 60	45 - 55
- Technical Director's Office (= Sleeping quarters)	25 - 35	25 - 40

This is usually a satisfactory solution of the hospital's permissible level.

ACOUSTIC BARRIER

The acoustic barrier provides a possible means to reduce the sound pressure level due to the direct field of the source at a given position. The distances between the barrier, the source, and the receiver are very important.

BARRIER - INSERTION - LOSS FORMULATION AND APPROXIMATION FOR BARRIERS

A simplified expression may be derived for the semi-infinite barrier in free-field environment for Sudbury General Hospital (Fig. 6).

For this case, the general expression for the insertion loss (4) as given by Equation 1 is:

$$IL = -10 \text{ Log } \left(\frac{\lambda}{3\lambda + 20\delta_1}\right) \text{ dB} \qquad \text{Eq 1}$$

where, λ = wave length (m or ft)

δ_1 = difference in direct path and diffracted path between the source and receiver (m or ft), and as designated in Fig. 1 is:

$$\delta_1 = [(R^2 + H^2)^{\frac{1}{2}} + (D^2 + H^2)^{\frac{1}{2}} - (R + D)] \text{ m or ft}$$

$$\delta_1 = \{R[1 + \frac{H^2}{R^2} - 1] + D[(1 + \frac{H^2}{D^2})^{\frac{1}{2}} - 1]\} \text{ m or ft} \qquad \text{Eq 2}$$

We shall assume that (Fig. 1) $D >> R \geq H$

which allows to reduce δ_1 to $\delta_1 = R[(1 + \frac{H^2}{R^2})^{\frac{1}{2}} - 1]$ m or ft Eq 3

Applying the binomial theorem and keeping only the first two terms, one obtains:

$$(1 + \frac{H^2}{R^2})^{\frac{1}{2}} \approx (1 + \frac{H^2}{2R^2})$$

which is substituted into Equation 3 to obtain:

$$\delta_1 \approx \frac{H^2}{2R} \text{ m or ft} \qquad \text{Eq 4}$$

We substitute Equation 4 into Equation 1 to obtain:

$$IL \approx 10 \text{ Log } \left[\frac{\lambda}{3\lambda + (10H^2/R)}\right] \text{ dB} \qquad \text{Eq 5}$$

and from theory assuming that:

$$3\lambda << \frac{10H^2}{R}$$

one finally obtains:

$$IL \approx 10 \text{ Log } \left(\frac{10H^2}{\lambda R}\right) \text{ dB} \qquad \text{Eq 6}$$

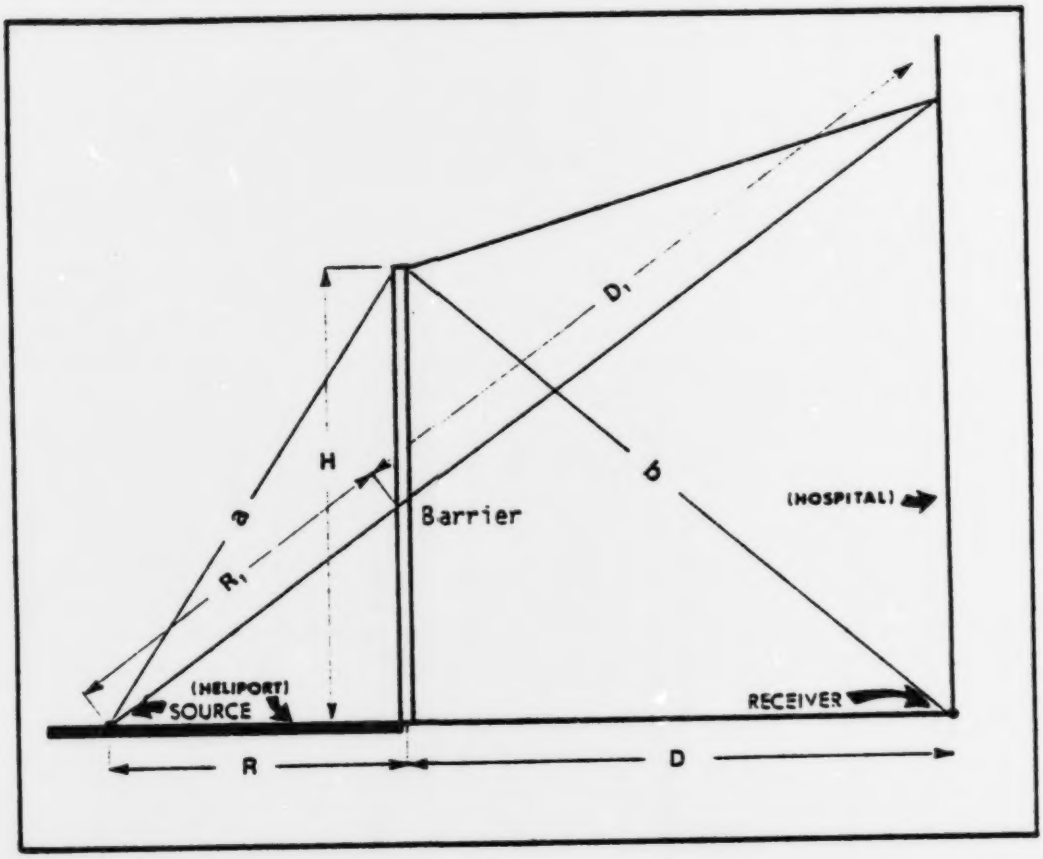


Fig. 6 - A semi-infinite barrier (general).

In Fig. 7 we see that a barrier would be ineffective as a method of noise abatement since the major portion of noise from the helicopter is during take-off and landing. The helicopter engine is not running during patient transfer to and from the helicopter (per discussion with pilot).

SOUND TRANSMISSION THROUGH WINDOWS

The existing windows found at the Sudbury General Hospital provide an attenuation factor of approximately 23-25 dB. Since the noise from the helicopter is not too high, this is satisfactory. Sound transmission through windows varies with the frequency of the sound and the weight (or mass). The Transmission Loss (TL) at 'double windows' performs better than the mass law predicts.

In order to better understand this problem, information is provided regarding the Sound Transmission Class of window and glazing.

The Sound Transmission Class (STC) is a single-number classification used to rate the transmission loss of a wall. The higher the STC value, the more efficient the wall is in reducing sound transmission.

Table 3 - Determination of Sound Transmission Class (5).

STC - ratings of windows and glazing.

	Construction	Thickness	Weight (lb/ft^2)	STC Rating
Poor	D.S. glass	1/8" (3 mm)	1 - 1/2	21
	1/4" plate glass	1/4" (6 mm)	3	26
	1" insulating glass	1" (2.5 cm)	6 - 1/2	32
Good	9/32" laminated acoustical glass*	9/32"	3 - 1/4	36
	Glass block	3 - 3/4"	20	40
Excellent	Spaced glass (1/4" - 2" air space - 1/4"	2 - 1/2"	6 - 1/2	42

* "Acousta - pane 36"

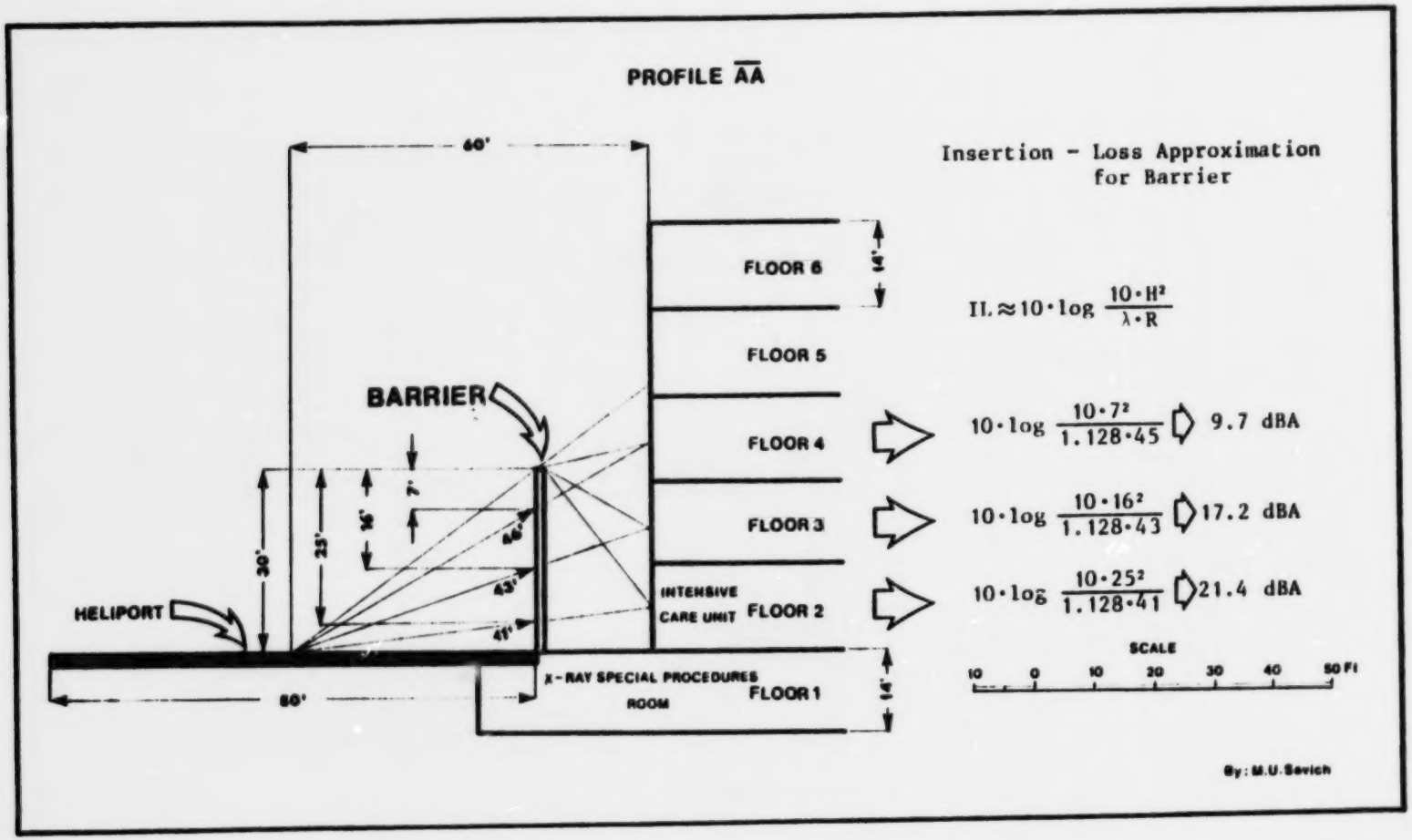


Fig. 7 - Insertion - loss approximation for barrier at Sudbury General Hospital.

Sound transmission through windows varies with the frequency of the sound and the weight (or mass).

HELICOPTER AS A SOURCE OF NOISE

At Sudbury Air Ambulance Base, noise measurements were taken on the Helicopter Bell 212, the same as used in the experiment at the Sudbury General Hospital (Fig. 8). Measurement of all frequencies show that in hover status it is predominately low frequency noise with the maximum noise level being 107 dBA. In idle status, noise level is approximately 90 dBA.

Table 4 shows the noise measurements taken at four points from a distance of 40 ft from the helicopter (projected heliport is 80 ft diameter). Measurements were taken with two instruments at the same time and point, and then averaged in dBA network. Two measurements at the right and rear were not taken since the helicopter was called out for an emergency.

Table 4 - Noise from helicopter at a distance of 40 feet

Status	dBA							
	Front		Left		Right		Rear	
	1+	2*	1	2	1	2	1	2
Idle	94	90	91	90	94	91	92	90
	92		90.5		92.5		91	
Hover (8 ft.)	106	106	107	102	-	-	-	-
	106		104.5		-		-	

Note: 1+ - Level Recorder Type 1306 without windscreen.
2* - Precision Integrating Sound Level Meter Type 1613 with windscreen.

Noise levels were also taken inside the helicopter in order to investigate the level of noise which a patient would be exposed to in the transport (Table 5).

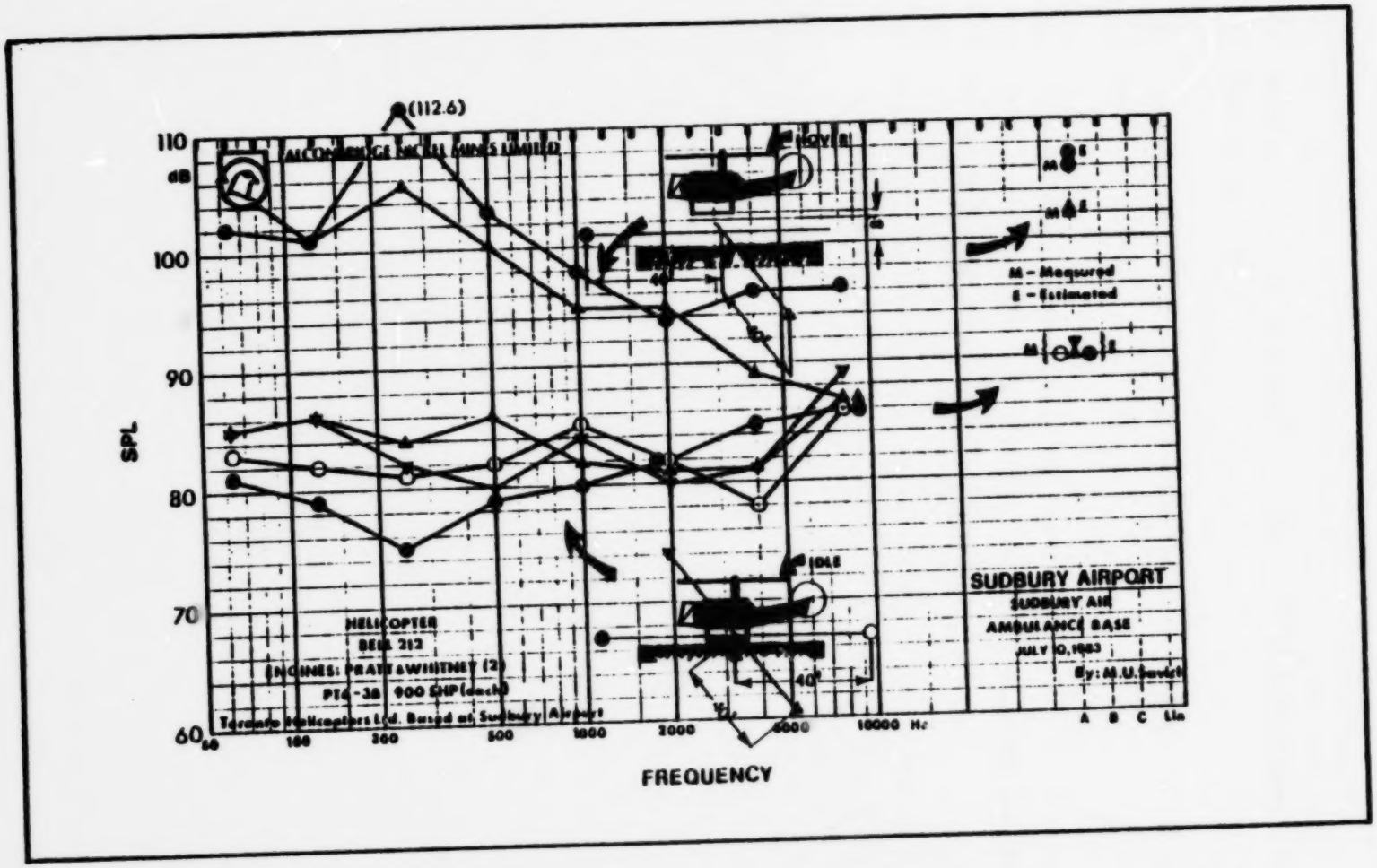


Fig. 8 - Frequency spectrum of noise at the helicopter Bell 212 at Sudbury General Hospital.

Table 5 - Noise inside helicopter

Status	dBA			
	Front		Back	
	Co-Pilot	Pilot	Left	Right
On ground, full rpm	94(?)	86	88	88
Hover 8 ft.	86	87	88	86
In flight	92	92	87	85

Note: Measured with Level Recorder Type 2306 from the pilot.

In general, one may conclude that the noise levels from the helicopter are not high enough to cause concern.

CONCLUSION

Noise measurements were taken at the Sudbury General Hospital, (Intensive Care Unit, X-Ray Special Procedures Room and Technical Director's Office), and of the helicopter at the Sudbury Air Ambulance Base.

This study indicates that use of an acoustical barrier is not an efficient method of noise attenuation at the hospital.

Our recommendation is that the glass in the windows of the rooms affected should be changed to acoustical glass or 'double windows'. This would provide an effective form of noise attenuation. Thus, the implementation of a heliport at the Sudbury General Hospital is feasible.

ACKNOWLEDGEMENTS

John K. Weglo, Director Environmental Control, Falconbridge Ltd., participated in the development of the project.

Juri Wallner, Associate Director Administration of the Sudbury General Hospital assisted in organizing the tests.

The crew of the helicopter were helpful in many ways and participated in making the measurements at Sudbury Air Ambulance Base.

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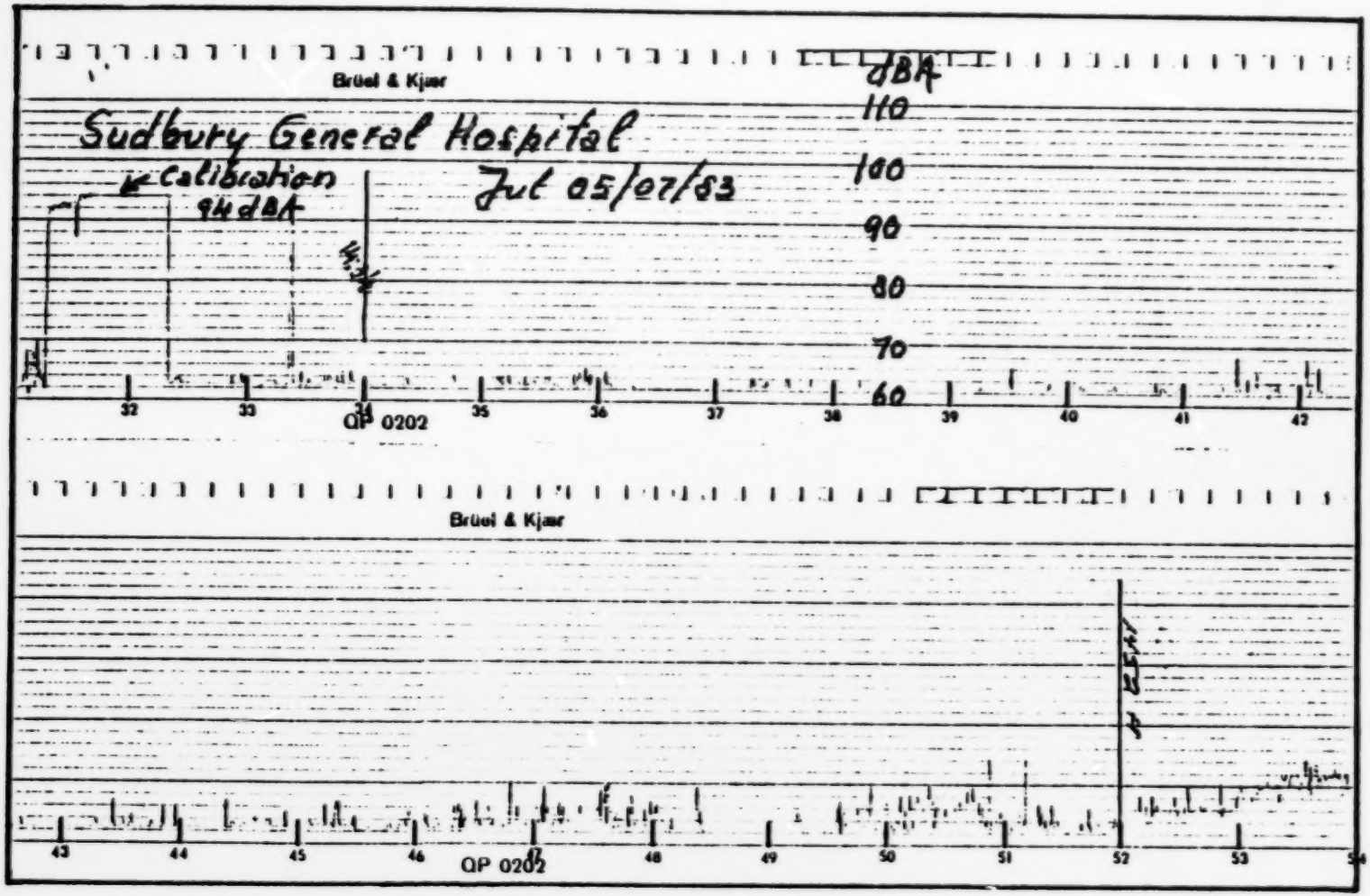
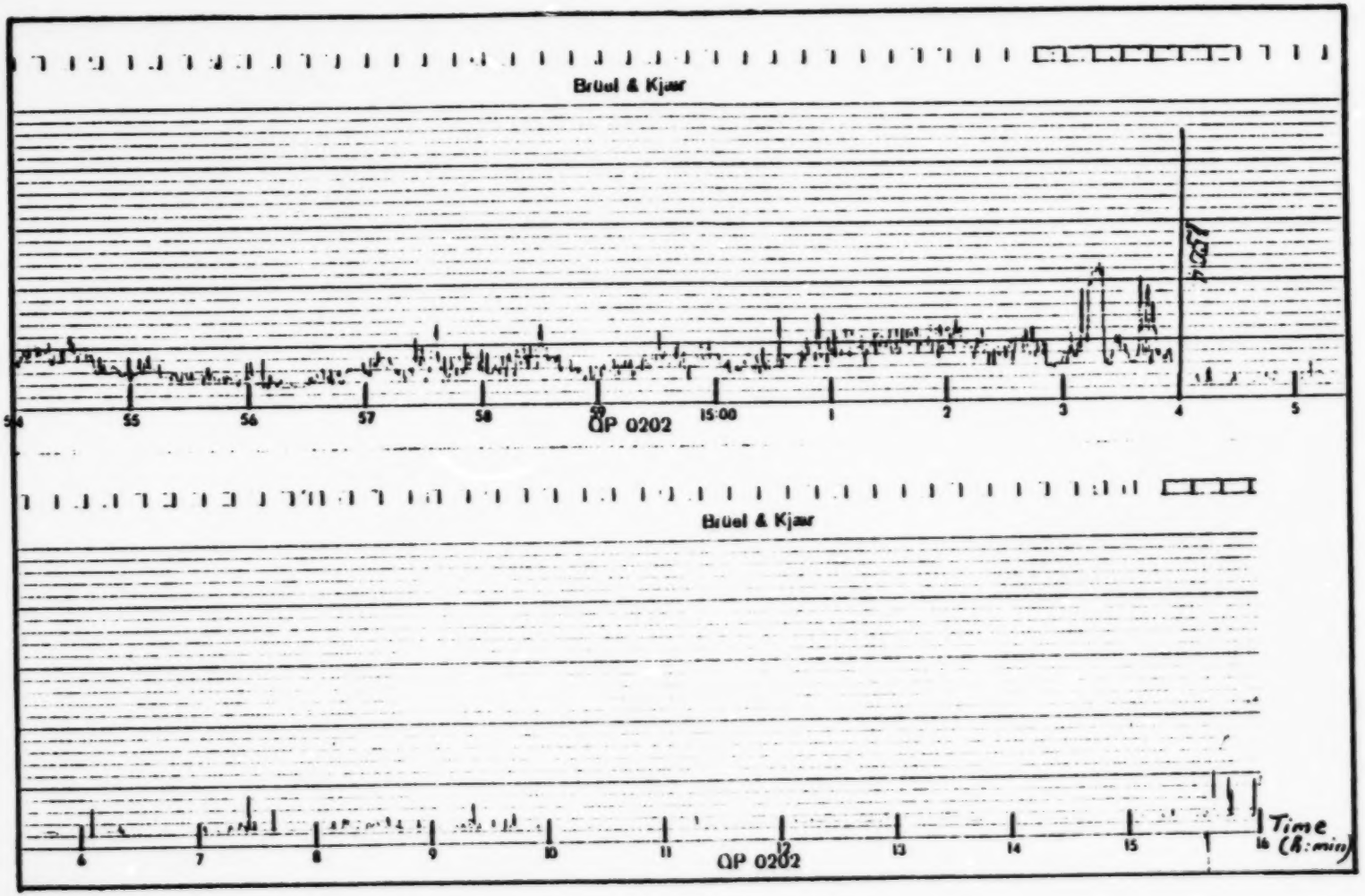


Appendix A - Time history graph from 14.34 h to 15.16 h, July 5th, 1983.



Appendix A - Continued.